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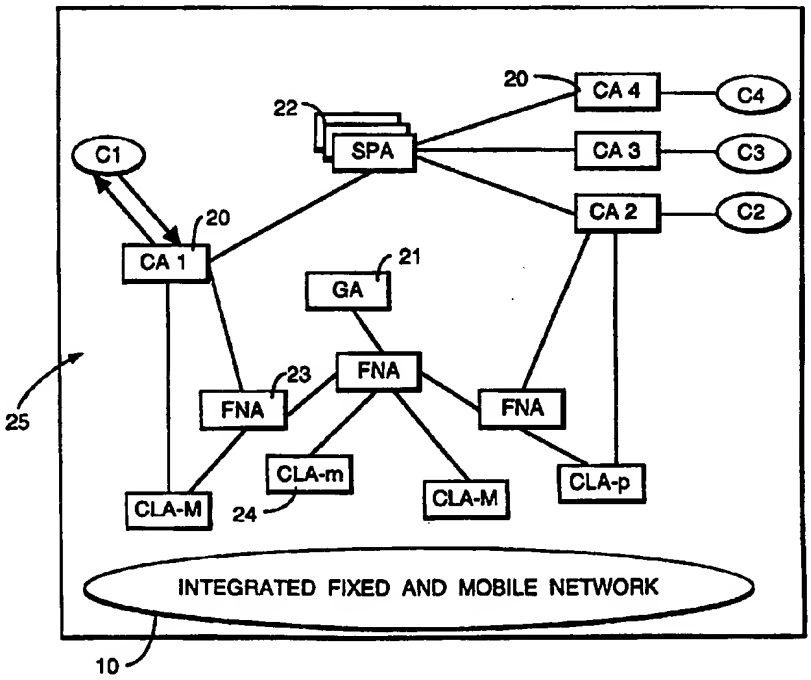
(57) Abstract

A services management system, which can provide services to a mobile user, can do so via a combination of network platforms (10). The system uses "Co-operating Intelligent Software Agent" technology in a heterogeneous agent architecture (25) to provide enough flexibility to deal with changing network constraints, for instance as the user moves. In an example, a fixed broadband network might be used in combination with radio transmitters of a mobile network. The agent architecture (25), involving autonomous agents working co-operatively, forms a layered system using the underlying fixed network (1) for inter-agent communication. In an application, a mobile user might move from a cell of the mobile network which can provide relatively wide bandwidth to one which can only provide limited bandwidth. The service management system can advise the user what services are available in either cell, at what price, based on current bandwidth usage at the two locations. If the user was already using a service which became unavailable in the new cell, the system will advise the user and, if appropriate, put the service effectively on hold until the user enters a cell in which the service is available once more.



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SERVICE PROVISION SYSTEM FOR COMMUNICATIONS NETWORKS

The present invention relates to service provision in communications networks and finds particular application where a communications user is mobile.

Communication networks are growing increasingly complex as the information technology (IT) industry produces new and varied services to be offered to customers. The rapid provision of these services is expected to be a key feature in distinguishing different network operators. Competitive advantages can be gained by communications network operators through the services that they offer, and the efficiency with which they manage those services. The customers (users) do not want to be aware of network complexity, such as the relationship between fixed and mobile networks. All they want is simple access to any service, and this applies whether they are connected to a fixed network or using mobile facilities.

Embodiments of the present invention provide a service management system, which can be used in the provision of services to a mobile user by means of more than one network platform. In particular, embodiments of the present invention can be used to provide services by means of a combination of a fixed and a mobile communications network, in spite of the differing constraints such as the more limited bandwidth available in mobile networks.

It has been recognised, in making the present invention, that the use of "Cooperating Intelligent Software Agent" technology in a heterogeneous agent architecture can allow service management in a complex environment such as the above. The basis for this technology is described in general terms in the publication "Distributed Artificial Intelligence" by M Huhns, Volumes I and II, published by Pitman, Morgan and Kaufmann in 1987. Indeed, cooperating intelligent agents can be used to provide quality and flexibility of control sufficient to meet the demands of leading-edge IT services, in spite of problems presented by multiple network platforms with conflicting constraints.

Embodiments of the present invention can be described as having a distributed architecture based on specialised intelligent software systems, that is agents, which cooperate to provide a range of services, some of which may be novel, across a network platform provided by integration of, for instance, a mobile

and a fixed network platform. Software agents for use in embodiments of the present invention can be designed to manage systems where there is a large amount of distributed information available and a large number of users with specific service requirements. Generally system management becomes more complex where users move between fixed and mobile networks while requiring/receiving services. This raises the problem of unifying the provisioning of services across various network platforms (mobile and fixed) and the effective management of the limited radio spectrum in contrast with the less constrained bandwidth in the fixed (broadband) networks.

A major problem foreseen with communications systems of the future is system complexity which is expected to limit the ability to exploit and reliably control communication networks. Intelligent agents used in embodiments of the present invention can achieve simplicity and robustness by spreading a control system over a plurality of specialised agents.

One type of agent provides the customer with an interface to manage the customer's interactions with the network, another cooperates to manage the network resources (cell bandwidth or capacity along the fixed network links) and a third type of agent facilitates specific services by linking network and customers together. As a result of agents interaction, intelligent services with special features that satisfy the customer and make better use of network resource, can be provided.

The agents accomplish their tasks by exploiting only local knowledge and using limited communications to inform each other of their actions and/or pass on knowledge. They negotiate with each other and by deciding the best option allocate tasks within the system. Their distributed nature makes them tolerant to both individual and multiple agent failure. This agent-based approach gives fast, robust and near-optimal solutions to resource allocation problems.

In addition to resource allocation, embodiments of the present invention also provide a mechanism by which service providers can make information available to customers. That information can be simply advertising-based but it can also provide a menu of information which is dynamically updated and from which the customer can select and activate service provision. The updating can take into account real-time constraints, such as bandwidth availability to a mobile

customer, so controlling options selectable by the customer in accordance with the real time constraints.

The options selectable could be controlled by being present or absent from a menu, or could be controlled according to content. For instance, a service could be available at different prices depending on a real-time constraint such as overall demand on bandwidth in a particular cell of a radio network.

A service provision system according to an embodiment of the present invention will now be described, by way of example only, with reference to the accompanying Figures in which:

Figure 1 shows an environment in which the service provision system would be advantageous;

Figure 2 shows a schematic diagram of a system architecture for use in the service provision system described below;

Figure 3 shows schematically the relationship between network management software agents and a network over which they have control;

Figure 4 shows schematically the internal structure of an agent; and

Figures 5, 6 and 7 show flow diagrams for three different scenarios for use of the service provision system.

Referring to Figure 1, an environment in which the service provision system might be applied comprises a fixed communications network 1, which may for instance be a broadband network, in combination with radio transmitters 2 of a mobile network.

The fixed (broadband) network 1 is the main carrier of long distance traffic and is represented for the purposes of this example to consist solely of Digital Main Switching Units (DMSUs) 3 which are nearly fully interconnected. Houses 4, offices 5, other buildings etc. are assumed to be connected in known manner to an appropriate node of the fixed network 1.

The radio part of the network is arranged into large (~10 km diameter) macro cells 6 and smaller (~500m diameter) micro cells 7. The former provide country wide coverage but a low bandwidth, the latter service local 'hotspots' with higher bandwidth available. Additional services are available through much higher bandwidth, small pico cells 8 - typically only a few meters across. These are assumed to be located in offices 5 and at special location points such as garages,

railways stations, motorway service stations, shopping centres etc. All radio cell transmitters 2 are connected in known manner to their local fixed network node.

The customer (user) may be mobile, travelling across cell boundaries 9 and requesting various services through his mobile handset, or may be at a fixed location having access to the integrated network through a terminal (ie video-telephone or computer terminal).

In this scenario, there will be at least one network provider involved, who provides and manages either one or both of the fixed and mobile networks concerned. There will also be at least one customer, who has access to one or both of the networks and may require services such as telephone calls or data provision, and at least one service provider. The service provider(s) may be independent of the network provider and merely provide services which are accessible by means of the network(s).

Normally any requested service will involve an end-to-end connection across the integrated network platform to another mobile/fixed customer or to a bank of data located anywhere in the network. For instance, the data might comprise any kind of stored information (text file, image file, manual page) that the customer would like to access for information retrieval or storage.

System Architecture

Referring to Figure 2, the following describes a heterogeneous system architecture based on autonomous agents working cooperatively to solve various service management problems in the mobile and fixed integrated network (MFIN) 10, shown in Figure 1.

The agents form a single layered system 25 using the underlying fixed network 1 for inter-agent communication.

The agents involved in the architecture can be grouped into three generic categories:

- "Interface Agents" comprising Customer Agents (CA) 20 and Gateway Agents (GA) 21.
- "Service Provider Agents" (SPAs) 22
- "Network Management Agents" comprising Fixed Network Agents (FNA) 23 and Cell Agents (CLA) 24

A Customer Agent CA 20 generally mediates between the agent system 25 and a customer or service provider while a Gateway Agent GA 21 provides a link such as a port, or interface, between the agent system 25 and another intelligent or non-intelligent management system (not shown) owned by an independent telecom operator. Hence, GAs 21 facilitate the transfer of information or requests between the agent system 25 and the external world.

The Service Provision Agents 22 are each responsible for a specific service, managing information about the provider(s) of that service and negotiating with those providers who wish to sell their resources. In an example, a customer might require some specific data but that same data may be found at different locations. A Service Provider Agent 22 will be activated in finding the optimal location from which the data will be provided.

The Network Management Agents 23,24 are mainly responsible for managing resources in the fixed network (FNAs) 23 and in the mobile network (CLAs) 24. As shown in Figure 2 the Cell Agents 24 can be of various types, depending on the type of cell they are managing: Macro Cell Agent (CLA - M), Micro Cell Agent (CLA - m) or Pico Cell Agent (CLA - p). The Network Management Agents 23,24 work cooperatively to collate their available local resources (i.e. link capacities and cell bandwidth) in a "resource configuration" required for a particular service. They also continuously update that resource configuration to deal with changes of delivery point for the service due to customer's mobility.

In principle, each agent is allowed to communicate with any other agent in the community with the exception of SPAs 22 which have communication channels only with Customer Agents (CAs). This provides a security measure in that SPAs 22 for service providers who are independent of the relevant network provider(s) are prevented from having direct access to network management or customer information. SPAs 22 are service-specific, and actual provision of a service to the system 25 is done by means of a CA 20. Hence, in practice, a CA 20 provides a customer request to an SPA 22 which then decides which other CA 20 (responsible for the resource required) should be contacted in providing the resource. Thereafter, the CAs 20 involved, the one providing the customer request

and the one associated with the resource, contact the network management agents which will set up the service.

Agents communicate by passing messages of fixed format. Messages have the generic form: [To, From, Job_ID, Content]

'To' identifies the agent or list of agents the message is sent to, 'From' identifies the originator agent sending the message, "Job ID" is a marker used in tracking jobs through the system, and 'Content' is the inter-agent message. When receiving a message each agent makes its own decisions triggering an internal task and/or deciding to communicate with other agents sending or requesting information.

Agents' Internal Architecture

Referring to Figure 4, the agents all have the following generic internal components: a parser 40, a world view 41 (database), a negotiator 42 (responsible for buying/selling resources), and a resource controller 43 (responsible for controlling the functional actions of the agent). These communicate by means of a common communication sytem or bus 44.

On receiving an incoming message from another agent, the parser 40 compares the message against standard templates to see which module should receive which message. For instance, a service_request would be processed by the negotiator 42 which would obtain information from the world view 41 on the status of the resource and the tasks the agent can perform. In comparison a service_acceptance would be passed to the resource controller 43 which would update the world view's record of active services.

The resource controller 43 handles all messages to and from the underlying resource system. For instance, when a customer comes into a new cell, a resource signal will come from the network to the resource controller 43 of a cell agent 24. An inform message, identifying a customer's location and associated pricing would then pass from the cell agent 24 to the parser 40 of a customer agent 20 and be handled by the World View 41 of the customer agent 20 to update the customer status. (This system is very similar to speech-act

languages with "inform" and "uninform" affecting the internal database (World View) requests being passed to the negotiator and agree/unagree to the controller).

All the modules are conveniently written in an object-oriented language, in particular Prolog although certain functional elements in the negotiator 42 and the parsers 40 I/O facilities might be written in C for speed and ease of implementation.

The negotiator 42 has a number of pricing strategies built in that price in different fashions according to the stage of the negotiation and the amount of resource available against that offered. The effectiveness of each strategy, for instance in terms of its profit, can be used to drive the frequency with which a strategy is employed.

NETWORK MANAGEMENT AGENTS 23,24

The role of network management agents is to manage, monitor and cost the provision of the basic network resources needed to provide a service. Each FNA 23 is responsible for managing a network node and each CLA 24 is responsible for managing a cell transmitter 2. The mapping between various types of network management agents and the physical integrated network is given in Figure 3, where the M, m, p are identifiers for the Macro, micro and pico agents respectively.

i) Fixed Network Agent (FNA) 23

These agents manage the flow of data through a network node and its associated links. (It should be noted that a node in this context is a switching unit, not shown, which is smaller than a DMSU 3. Multiple nodes may be connected to a single DMSU 3, and a single FNA 23 can manage more than one node).

Knowledge (stored & updated)

- local network topology (links and node(s) managed)
- neighbouring agents topology
- active services along managed links
- bandwidth usage
- price-bandwidth tabl

Functions Performed

- Monitor bandwidth usage along their managed physical links
- Cooperate with other FNAs using a distributed routing algorithm to find the shortest available route in the fixed network for a requested service
- Dynamic update of the route found through the fixed network on customer departure from the area managed by the FNA (that is, when a customer leaves the cells connected to the FNA and enters the area of another FNA)
- Cooperate with the CA 20 to find not only the mobile customer location (i.e. in which cell) but also if that is the right cell in terms of bandwidth required for the service. This facility is used for intelligent downloading of data cached when the available cell bandwidth allows it.
- Set up the service end-to-end connection merging the fixed network path with the radio paths to a customer's current cell
- Control data caching at its site and then download it along the end-to-end connected path

References are made above to "data caching". This covers the storing of data which a customer requires for transmission to the customer when the customer reaches a location at which downloading is possible. For instance, a customer may request a service requiring significant bandwidth at his/her location, and subsequently move to a location in which the bandwidth is no longer available, for instance by moving from a pico cell to a macro cell of a mobile network. The relevant data must therefore be cached until such time as the customer moves once more to a location where downloading is possible.

ii) **Cell Agent (CLA) 24**

For each cell in the integrated physical network 10 there is a Cell Agent 24 controlling it. Macro cells are arranged so that each is connected to only one FNA 23. Micros and picos are all encapsulated in macros and are connected to the macro cell in which they are embedded. Similarly, in the event that a pico is embedded geographically inside a micro it is connected to that micro cell. As shown in Figure 3, the cell agents 24 follow the same connectivity pattern as the cell transmitters 3.

Knowledge (stored & updated)

- parent cell agent connected to
- active services using that cell's bandwidth resources

Functions Performed

- Monitor bandwidth usage inside the cell they manage
- Dynamic price allocation based on current bandwidth usage level
- Monitor customer entering/leaving the cell and signal the customer's presence to his Customer Agent 20 via the parent cell agent, if any, or via a FNA 23 if connected straight to an FNA agent.
- Continuously offer resources to the Customer Agent 20. The message sent includes the following tuple:

[Customer_Agent, Path, Bits, Price]

where:

Path is the paths from the FNA 23, down to that cell agent.

Bits represents the available bandwidth on offer

Price is the desired selling price worked out by the cell agent

The last function presented above is central to the system, creating the possibility for resource managers of the network providers to offer continuously available resources at variable price (depending on the current bandwidth usage) to potential customers and not only when those resources are required by a requested service. This increases the potential usage of network resources and implicitly creates new and flexible opportunities for the customer wanting to use those resources.

When a service is established (by negotiation with the resource managers) the service is implemented by the resource managers, on behalf of the network providers rather than the service providers. At this point, a data download for instance might make use of caching facilities provided by the fixed network.

Thus, the network management agents' job is to sell resource at a price that they dynamically allocate based on current bandwidth usage.

INTERFACE AGENTS

i) Customer Agent (CA) 20

The role of the Customer Agent 20 is also very important in the system. It provides a 'one interface per customer' facility for various types of customers.

A main role is to present and negotiate customer requests for services with the system. Another major role however, is to offer proactively various services to the customer when and where they become available to him/her.

Additionally, a customer may not only request a service but may also offer resources that other customers want to use (i.e. databases of information, people resources). The functions of the Customer Agent can be expanded to take this into account. The following provide examples of relevant customer agent types:

- Personal Customer Agent (deals with a person offering services or capturing services requirements)
- Database Customer Agent (manage data resources, sell data to other agents/customers)
- Computer Customer Agents (manage processor resources, provision of on/off line computation power)

For the purposes of the present description, further details of the design/function requirements of the first two types of Customer Agent 20 are given below. (These are relevant to the descriptions of the system in use given under "Scenarios and Services" below.)

i)a Personal Customer Agent

Knowledge (stored & updated)

- customer's current location
- customer's business profile (history of services requested by the customer, although this may be a facility of a future business agent which may be added to the current system)
- generic range of services offered by the relevant operator
- payment requirements pre-input by the customer (optional)
- billing and pricing information

Functions Performed

- customisable interface (one customer agent is created for each customer)

- takes customer's request for service information and mediates the dialogue with the service provider agents (SPA) 22 sending information back to the customer
- receives resource offers at a certain price from the network management agents 23, 24 and matches them against the range of services deciding which services can be provided to the customer
- allocates prices to services based on the price of network resources on offer and weights them in accordance to customer's business profile
- offers those services to the customer (i.e. sends available service information (Service_Type, Price) to appear as distinctive icons on the customer's mobile handset display: the customer deciding to take advantage of the service offer then has only to select the relevant icon)
- after taking in the customer request for a service, puts it forward to the service provider agent 22 (eg Road Map Provision agent) and then sends a request to the relevant network management agents 23, 24 for service set-up)
- all incoming services are checked by a CA 20 before contacting the customer (to take account of call blocking, priority interruptions)
- while a service is active and the customer is moving the Customer Agent continuously sends messages updating customer's current location to the network management agents 23, 24 for route (of the service) update
- Monitor Service quality (if there is not enough bandwidth for that service in the current customer's cell, the CA 20 receiving the resource offer from the cell may decide to downgrade the service - e.g. video link to audio - if this is agreed by the customer, or use the caching facility, in the case of data transfer to the customer, to put the service on hold till a new 'valid' bandwidth offer arrives from another cell the customer moves into)
- take customer request to cancel the service and inform the other agents responsible for the service (i.e. the network management agents 23, 24 to release the bandwidth previously used in the service).

In the early stages these agents will check a request against internal criteria, price it by business directed pricing and establish contacts with the resource management agents to build the service. Later generations will learn patterns of customer behavi ur, price services to stimulate revenue inside the

constraints set by business agents and negotiate the best rate for the necessary resources.

i)b **Database Customer Agent**

The Database Customer Agent is the interface attached to any bank of data that the system may facilitate access to, for various other personal customers.

Knowledge (stored & updated)

- Database location and its connectivity to the physical network
- generic range of items offered by the database
- generic payment information
- current utilisation of database resources

Functions Performed

- allocate prices to database services based on the current utilisation of data resources
- offer those priced services in response to the service provider agent's request
- after being chosen by the service provider agent 22 as a source of data, the Customer agent 20 sends a request to the relevant network management agent 23, 24 (closest FNA 23) for data caching
- when it receives the network management agent (closest FNA 23) acknowledgement the Database Customer Agent validates the transfer of data to be cached at FNA 23 site.

ii) **Gateway Agent (GA)**

Gateway agents translate between systems, effectively providing a language translator enabling different systems to negotiate. If the other system is not intelligent and does not negotiate, the gateway agent can act as a shell providing an intelligent interface. Note this suggests one gateway agent per network interface.

SERVICE PROVISION AGENTS 22

Service provision agents 22 are not a generic family. Each type of service that can be offered is operated by a service provision agent. Their job is to provide the link between services and network. For simple point-to-point services such an agent is relatively simple. However by breaking service provision down in this way we can provide intelligence where it is needed. A service provision agent 22 can buy and sell (negotiate for) data, computing resources, people or network bandwidth from the customer agents interfacing with such resources or from network management agents.

This enables the provision in a simple fashion of new intelligent services. Rather than describe all the possible details of such agents, a typical example is given below as the SPA agent used below in the "Intelligent Services" scenario.

Knowledge (stored & updated)

- Engineers it is managing
- Customers registered with the service
- Generic payment information
- List of customers in need of service
- Know where data on cars is located

Functions Performed

- request time-distance to customer from engineers
- match engineers to customers
- inform engineers of next job
- buy car repair data to pass to engineers in need

This service provision agent provides the network operator effectively with two customers - the person who is requesting the service and the company (service provider) who runs the breakdown service. Service provision agents 22 can act on behalf of more than one network customer.

SCENARIOS AND SERVICES

The following three scenarios have been chosen to demonstrate use of the service provision system described above.

Interactive Service Provision

In this scenario a customer with a telephone moves between different types of radio cell. The underlying network equipment will detect such cell changes in known manner and update its location records. A resource signal is then directed from the network to the resource controller of the new cell agent 24.

The cell agent 24 for the cell to which the customer moved examines the current traffic load in the cell and uses an algorithm to select a capacity and price for use of the cell's facilities. It then offers this capacity-price tuple to the customer agent 20 of that customer. The customer agent 20 then checks the range of services that the customer has subscribed to, including any price limits the customer has requested, checks the price offered by the cell against any current business strategies for pricing calls and offers a list of service-price tuples to the customer's phone unit. These might best be displayed as icons on a display of the phone unit, with the appropriate associated pricing, or in any other suitable manner.

"Current business strategies" in this context are strategies of the service provider which may affect the service-price tuples produced. An example of such a strategy might be where the service provider offers a customer a bulk rate for a service where the customer's usage goes above an agreed threshold.

The services offered will vary from cell to cell, with available capacity. A point-to-point continuous service that is extant on crossing a cell boundary but which requires more capacity than is then available, in the new cell, or which would require a significant increase in cost (say a video call on moving into a macro cell from a micro), will be either downgraded by the customer agent to a lower call type, or will show an increased cost. Data services which do not require a continuous link are managed differently (see "Intelligent Data Services" below). The services displayed can include normal telephony, compressed video, full video, one-touch emergency services and two data download services, for instance.

Referring to Figure 5, the above can be described with reference to a flow diagram:

STEP 501: the network detects the transfer of customer equipment to a new cell

STEP 502: the network outputs a resource signal to the resource controller 43 of the cell agent 24

STEP 503: the resource controller of the cell agent 24 logs an update in the World View of the cell agent 24

STEP 504: the World View sends the update information to the negotiator of the cell agent 24

STEP 505: the negotiator 42 generates a capacity-price tuple based on resource availability and sends it to the Customer Agent (CA) 20 for the relevant customer, via the cell agent's parent cell agent where there is one, or directly via the Network Agent 23

STEP 506: the resource controller 43 of the CA 20 receives the tuple and sends it to the World View of the CA 20

STEP 507: the World View assesses the services available and advises the negotiator of the CA 20

STEP 508: the negotiator checks-

- range of services subscribed to
- price limits set by customer
- current business strategies

STEP 509: negotiator generates list of service-price tuples

STEP 510: the negotiator of the CA 20 outputs the list to the customer display unit

The components of the various agents can be seen from the above to deal generally with operations which are relevant to different of the overall system. For instance, the World View deals with data-related operations, the resource controller with physical resource-related operations and the negotiator with pricing operations. However, the boundaries between the types of operation performed by each component may be defined appropriately and may well be different in different circumstances.

The above scenario shows in particular the interworking between network and customer agents.

Intelligent Data Services

In the following scenario, the customer and network agents 20, 23, 24 combine to download data intelligently. A customer has requested a data download, for instance from an information source to his computer, or road maps to his video phone etc. Clearly, it is preferable to the customer that this is done quickly and cost effectively. The parameters on either could have been set by the customer. For instance, the customer might specify that he wants data to be downloaded at 64 Kbit/s. He may however move to a typical macro cell, offering only a voice channel (8 Kbit/s). The system can be set such that the data is then retrieved, and cached by a fixed network agent (FNA) 23, but not sent yet to the customer.

In practice, the fixed network agent will generally be loaded onto computer facilities of some sort, and these facilities will generally offer storage capacity. It is to this storage capacity that the data will be cached, the FNA 23 treating it as an available physical resource equivalent to a network resource.

The network agent 24 requests that the customer agent 20 informs it as soon as the customer is in a cell with the right price-capacity values. That is, it effectively sets a flag in the World View 41 of the CA 20 which will be triggered by information coming in from a new CLA 24. Once informed, the network agent 23 downloads as much data as possible until the customer agent 20 informs it that

the customer is again changing cells. The data connection thus tracks the user round the system, exploiting the available capacity (or price) as available.

Referring to Figure 6, this can be described in terms of the following flow diagram steps:

STEP 601: customer transfers to a new CLA 24

STEP 602: new CLA 24 outputs a capacity-price tuple (or relevant data) and it is recognised that the new CLA 24 cannot support further data download

STEP 603: the FNA 23 sets a flag in the World View of the CA 20 that the CA 20 should inform the FNA 23 as soon as the customer has moved to a CLA 24 which can support the data download, and starts to cache the incoming data

STEP 604: customer moves to second new CLA 24

STEP 605: CA 20 notifies FNA 23 that this CLA 24 can support the data download

STEP 606: The FNA 23 starts to download data

It may be that the customer will actually move to a cell associated with a new Network Agent 23. In this case, when the flag is triggered and the original network agent 23 is notified, it will recognise that the new cell agent (CLA) 24 is not one of its own. The original NA 23 will then interrogate one or more NAs to which it is connected, which may in turn have to interrogate other Nas, until an NA 23 which recognises the new CLA 24 is located. The original NA 23 will then hand over all the relevant information that it holds to the new NA 23.

Intelligent Services

A third scenario demonstrates intelligent service agents. Their job is to coordinate customer agents 20 and network resources as appeared in the previous scenario. In this scenario they demonstrate value-added intelligence of their own.

A customer is in a car which breaks down. He touches the "emergency breakdown" icon on his screen. The call is connected to a service provider agent (SPA) 22 which requests location and fault description. The service provider agent 22 manages a group of engineers in the field. It interrogates their customer agent 20 with whom each engineer logs his current job status. The service provider agent 22 negotiates with the customer agent to find an engineer who can most quickly be directed to the job then downloads the information required to the engineer. The service provider agent 22 thus acts on behalf of two customers - the broken down customer and the engineer agency. Such network intelligence could be used for any dispatch service which involves scheduling. Currently it is implemented as a reactive, negotiation based service but alternative algorithms could be implemented.

The main features of this service are:

- Provides a complete application for scheduling engineers
- One touch service to customer - no numbers to remember
- Can be expanded to range of services with the intelligence in the network
- Each service has a dedicated service agent - easy to produce new services.

Again, this service can be expressed in terms of a flow diagram. Referring to Figure 7, the steps are:

STEP 701: customer requests engineer via touch screen

STEP 702: customer's CA 20 transfers request to an SPA 22 relevant to an engineering service

STEP 703: the SPA 22 interrogates the customer's CA 20 for further information, such as location and fault description

STEP 704: the SPA 22 then interrogates each of the engineer's CAs 20, there being a CA 20 allocated to each, to obtain data on the circumstances of each engineer

STEP 705: the SPA 22 negotiates to decide the best engineer in the circumstances

STEP 706: the SPA 22 downloads the customer information to the selected engineer's CA 20

It will be clear to a person skilled in this technology that there are several novel and advantageous aspects of a system as described above which might be used, independently or in combination with other aspects. For instance, it is advantageous that, in a system as set out in Claim 1 below, it is possible to embed updatable business strategies, for instance reflecting special pricing packages of the service or network provider.

Further, it is advantageous that a service provider, as described in relation to Figure 7, can automatically optimise a service offer, by taking into account for instance real-time location and availability of personnel or equipment which represent alternative sources of that service provider's service.

CLAIMS

1. A service provision system for use with a communications network to provide a plurality of services to a network user, wherein data relevant to the plurality of services can be made available to the user, and the user can select one or more services to be provided, said system including control means comprising a plurality of software agents, individual agents of said plurality comprising data in respect of respective entities relevant to service provision by means of the network, said system further comprising updating means for updating data held by at least some of said software agents, the control means controlling the data made available to the user and responsive to selection of a service by the user to trigger a process for providing the selected service to the user.

2. A system according to Claim 1 wherein said communications network comprises at least in part a mobile communications network and the user has access to said mobile network.

3. A system according to Claim 2 wherein the control means is responsive to transfer of the user between cells of the mobile network, said cells having different resources to offer in respect of services to the user, to update data made available to the user which is affected by said transfer.

4. A system according to Claim 3 wherein at least one of the services potentially available to the user is affected by bandwidth availability in the cell in which the user has access to the mobile network, and the control means may update the data available to the user in terms of either availability of such service or the price at which it would be available.

5. A system according to either of Claims 3 or 4 wherein at least one of the services potentially available to the user involves the downloading of data to the user, which downloading is affected by bandwidth availability in cells of the mobile network, said system further comprising means to store data requested by the

user as a consequence of selecting a service, the control means controlling downloading of said data to the user such that it is stored at times that bandwidth is not available for said downloading, and downloaded subsequently when bandwidth becomes available.

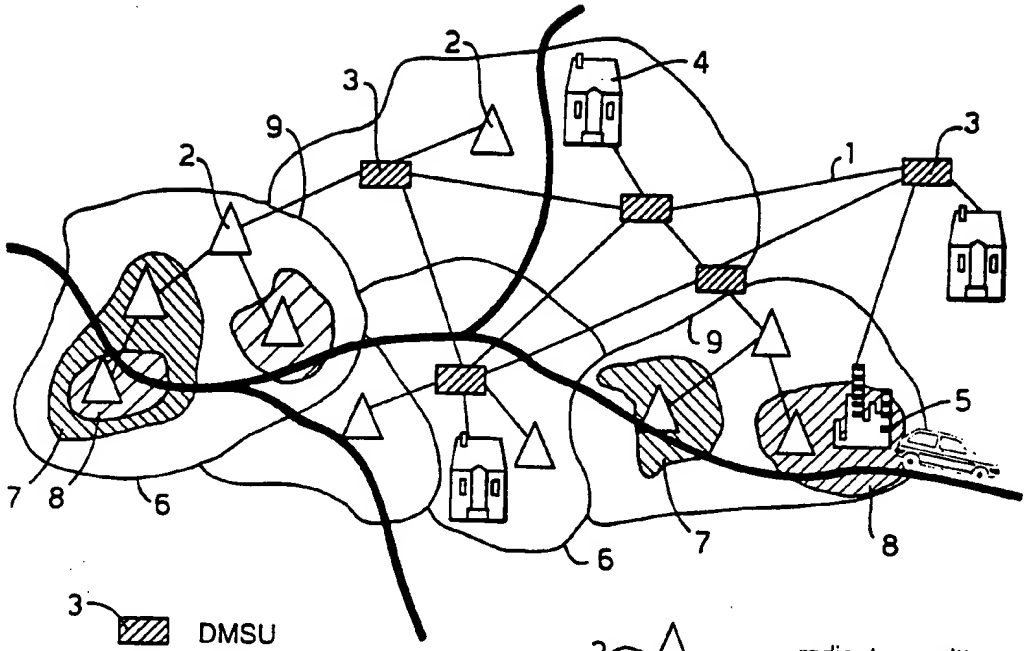
6. A system according to Claim 5 wherein the control means includes means for tracking the location of the user with respect to the mobile network for the purpose of downloading the data to the user by means of appropriate routing through the communications network or networks.

7. A system according to any one of the preceding claims wherein the data relevant to the plurality of services includes real-time pricing data such that the user can take the real-time pricing data into account prior to selecting a service.

8. A system according to any one of the preceding claims wherein a plurality of said individual agents are each allocated a facility for offering a common service, each of these individual agents holding real-time data in respect of its allocated facility's capacity to offer the service, and the system selects one of the allocated facilities on which to base notification to the user of current conditions under which a service might be provided.

9. A system according to any one of the preceding claims wherein at least one of said agents comprises means for storing an updatable business strategy, and the system accesses said business strategy prior to making cost-related service data available to a user, such that said business strategy can be applied to said cost-related service data to modify the data appropriately.

Fig.1.


2
3
4
9
2
1
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8

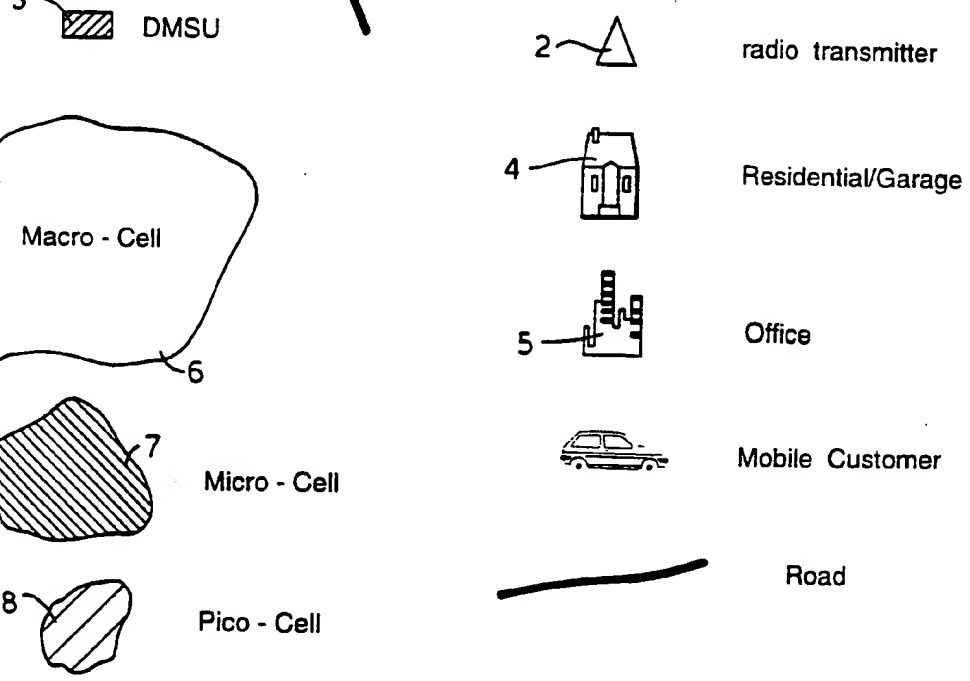

3
DMSU
2
radio transmitter
Macro - Cell
6
4
Residential/Garage
5
Office
7
Micro - Cell
Mobile Customer
8
Pico - Cell
Road

Fig.2.

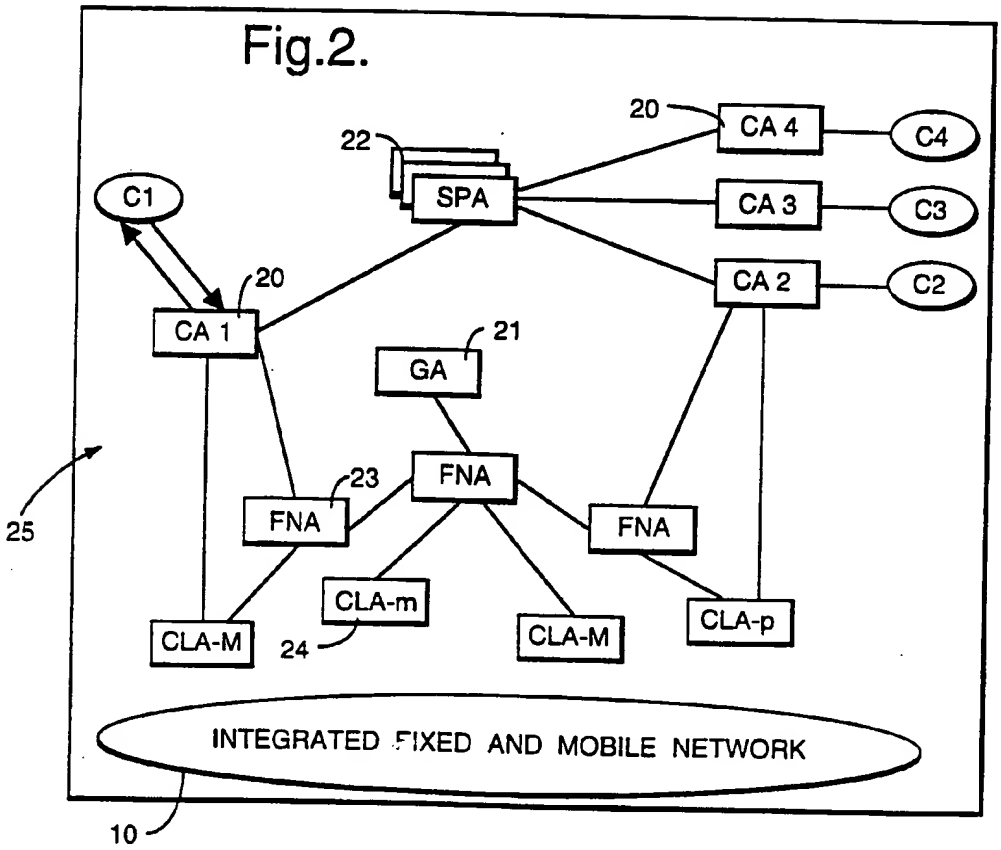

20
CA 4
C4
22
SPA
CA 3
C3
C1
CA 2
C2
20
CA 1
21
GA
23
FNA
FNA
FNA
25
CLA-m
CLA-M
24
CLA-M
CLA-p
INTEGRATED FIXED AND MOBILE NETWORK
10

Fig.4.

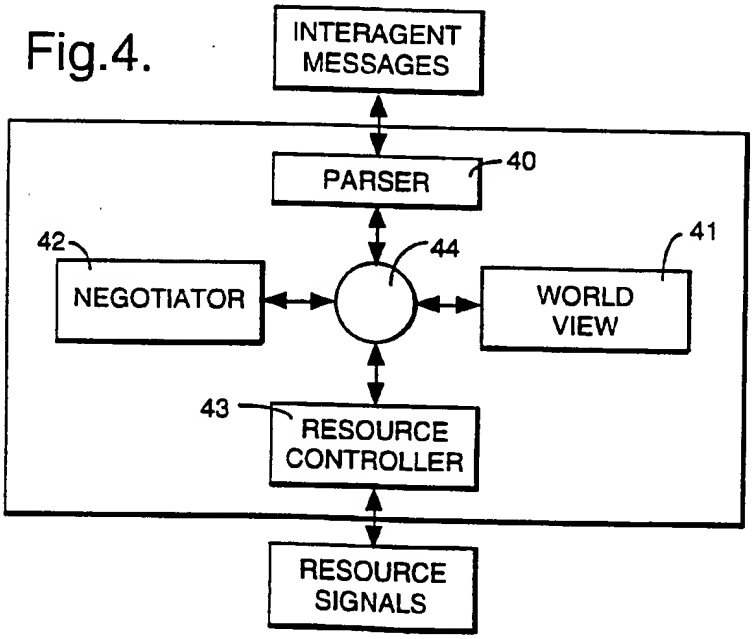

INTERAGENT MESSAGES
PARSER
40
42
NEGOTIATOR
44
41
WORLD VIEW
43
RESOURCE CONTROLLER
RESOURCE SIGNALS

Fig.3.

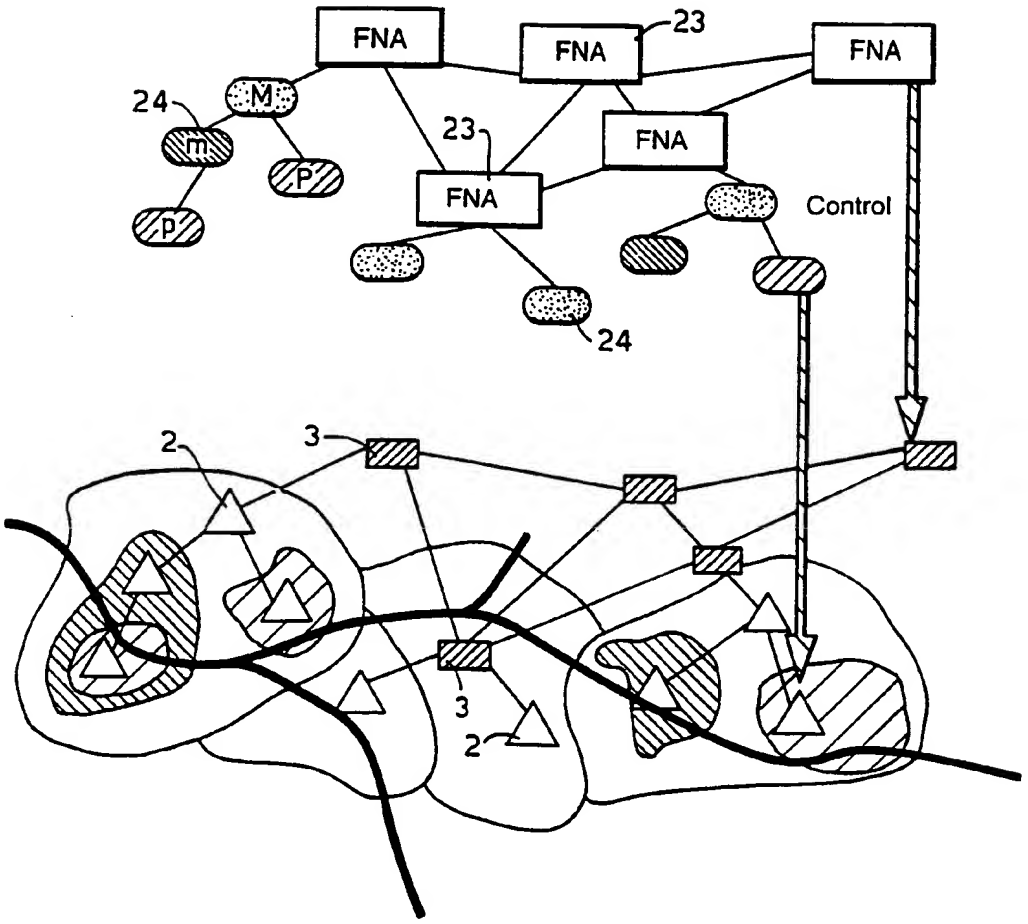


Fig.5.

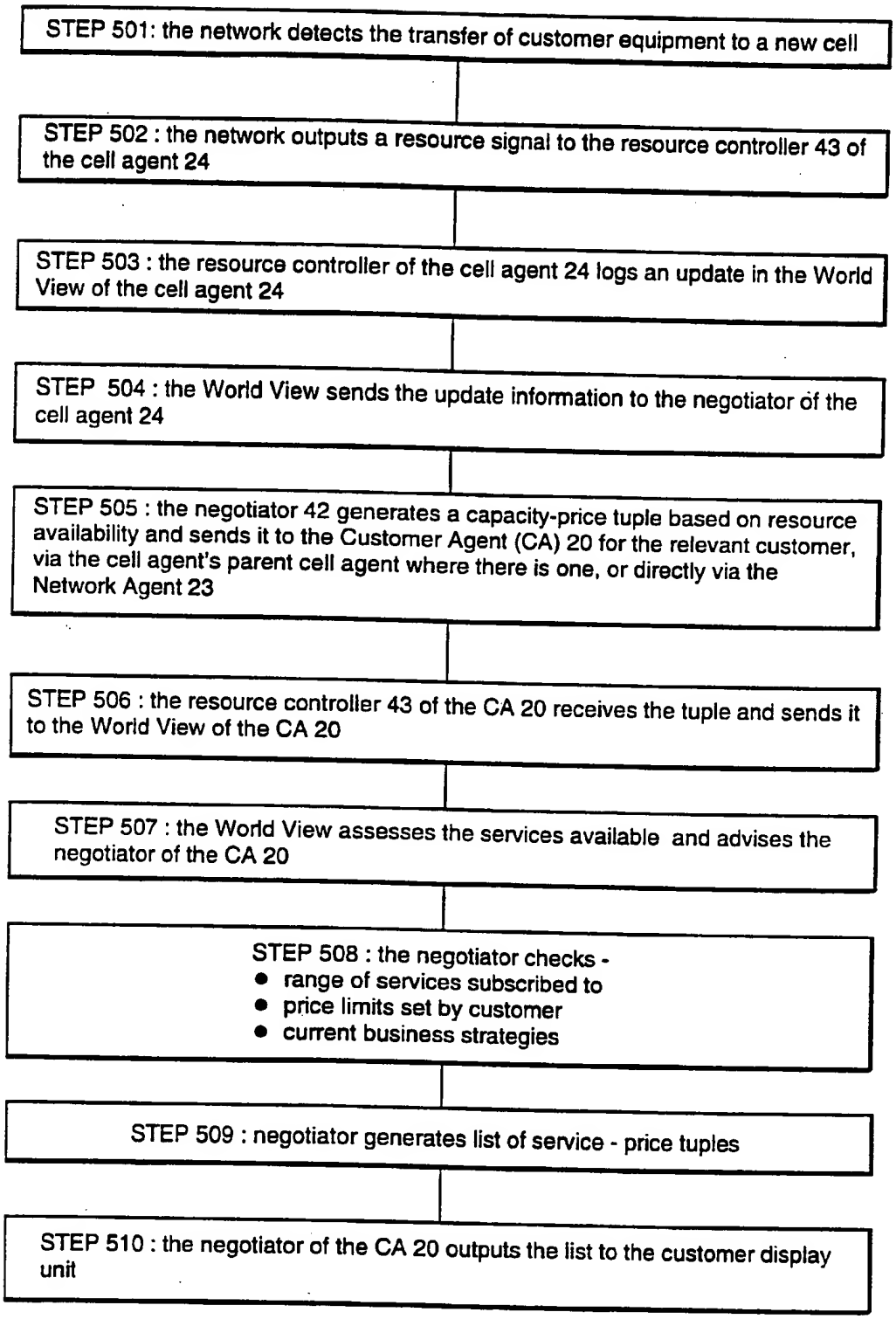

STEP 501: the network detects the transfer of customer equipment to a new cell
STEP 502 : the network outputs a resource signal to the resource controller 43 of the cell agent 24
STEP 503 : the resource controller of the cell agent 24 logs an update in the World View of the cell agent 24
STEP 504 : the World View sends the update information to the negotiator of the cell agent 24
STEP 505 : the negotiator 42 generates a capacity-price tuple based on resource availability and sends it to the Customer Agent (CA) 20 for the relevant customer, via the cell agent's parent cell agent where there is one, or directly via the Network Agent 23
STEP 506 : the resource controller 43 of the CA 20 receives the tuple and sends it to the World View of the CA 20
STEP 507 : the World View assesses the services available and advises the negotiator of the CA 20
STEP 508 : the negotiator checks -
• range of services subscribed to
• price limits set by customer
• current business strategies
STEP 509 : negotiator generates list of service - price tuples
STEP 510 : the negotiator of the CA 20 outputs the list to the customer display unit

Fig.6.

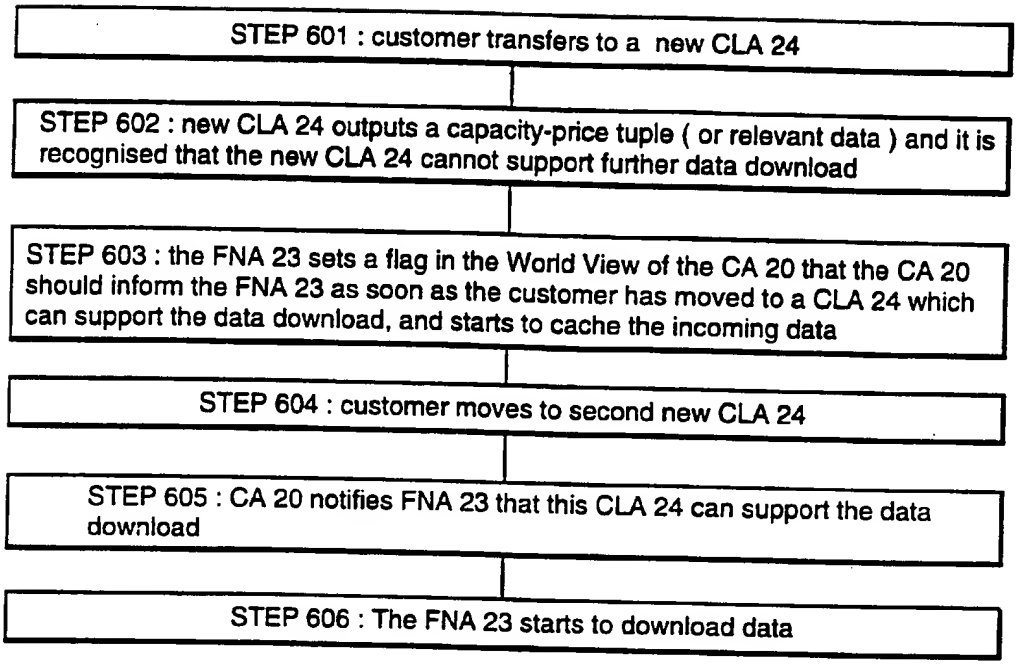
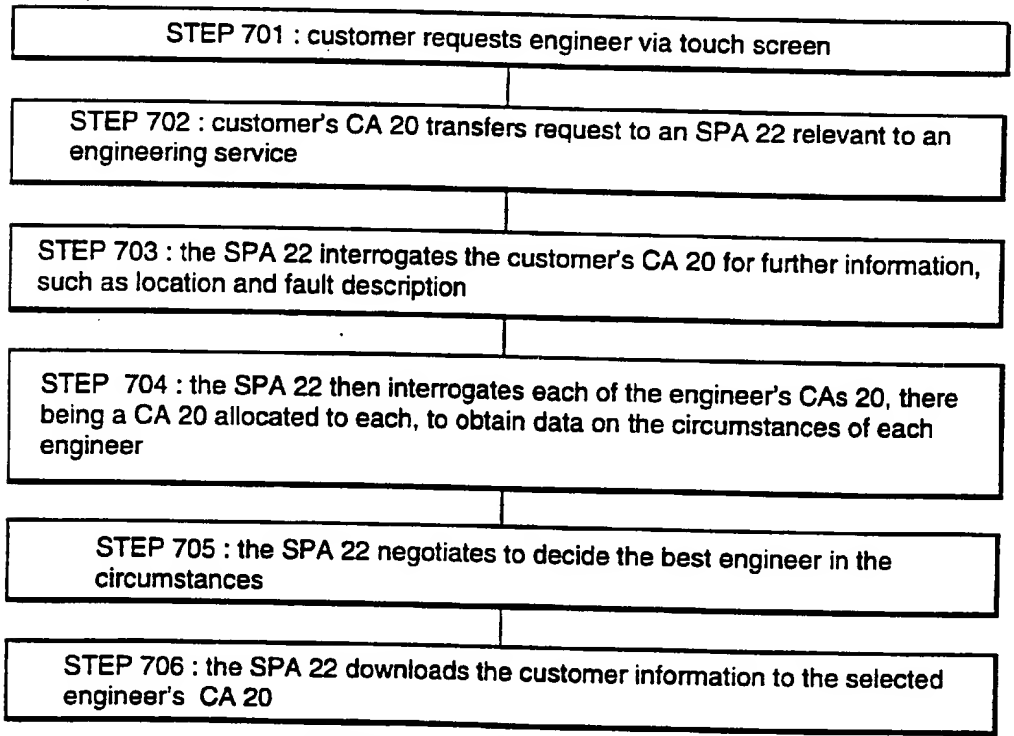

STEP 601 : customer transfers to a new CLA 24
STEP 602 : new CLA 24 outputs a capacity-price tuple (or relevant data) and it is recognised that the new CLA 24 cannot support further data download
STEP 603 : the FNA 23 sets a flag in the World View of the CA 20 that the CA 20 should inform the FNA 23 as soon as the customer has moved to a CLA 24 which can support the data download, and starts to cache the incoming data
STEP 604 : customer moves to second new CLA 24
STEP 605 : CA 20 notifies FNA 23 that this CLA 24 can support the data download
STEP 606 : The FNA 23 starts to download data

Fig.7.


STEP 701 : customer requests engineer via touch screen
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STEP 705 : the SPA 22 negotiates to decide the best engineer in the circumstances
STEP 706 : the SPA 22 downloads the customer information to the selected engineer's CA 20

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 95/00988

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO-A-93 16543 (TELEFONAKTIEBOLAGET LM ERICSSON) 19 August 1993 see page 8, line 2 - line 13 see page 8, line 20 - page 9, line 11 see page 11, line 5 - line 23 see page 12, line 4 - line 25 see page 12, line 34 - line 38 see page 13, line 30 - page 14, line 5 see page 15, line 39 - page 19, line 35 see page 20, line 26 - page 21, line 4 see page 21, line 30 - page 22, line 17 see page 22, line 32 - page 23, line 4 see page 24, line 35 - page 26, line 16 see page 28, line 12 - line 28 see page 33, line 20 - line 23 --- -/--	1,2

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 1995	28.09.95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Gerling, J.C.J.

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 95/00988

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	BRITISH TELECOM TECHNOLOGY JOURNAL, vol. 9, no. 3, July 1991 IPSWICH (GB), pages 97-105, D G GRIFFITHS ET AL 'The role of intellignet software agents in integrated communications management' see page 98, left column, line 3 - right column, line 21 see page 99, right column, paragraph 2.2 see page 100, left column, paragraph 3. - page 103, right column, paragraph 5.3 ---	1
X	ERICSSON REVIEW, vol. 70, no. 4, 1993 STOCKHOLM SE, pages 156-171, XP 000415352 L. SÖDERBERG 'Evolving an Intelligent Architecture for Personal Telecommunication' see page 157, right column, line 50 - page 160, right column, line 24 see page 162, right column, line 28 - page 167, right column, line 7 see page 168, middle column, line 13 - right column, line 5 ---	1,2
X	EP,A,0 358 408 (AMERICAN TELEPHONE & TELEGRAPH) 14 March 1990 see column 2, line 40 - column 5, line 45 see column 6, line 30 - line 43 see column 8, line 12 - line 38 see column 10, line 49 - column 11, line 14 ---	1,7-9
X,P	WO,A,94 28683 (BRITISH TELECOMM) 8 December 1994 see page 1, line 1 - line 8 see page 2, line 4 - line 21 see page 7, line 27 - page 9, line 3 see page 11, line 28 - line 34 see page 23, line 10 - page 24, line 8 see page 30, line 15 - page 31, line 32 ---	1,2,7-9
A	ELECTRONICS AND COMMUNICATION ENGINEERING JOURNAL, vol. 5, no. 3, June 1993 LONDON GB, pages 165-172, XP 000377793 W.VAN DEN BROEK ET AL 'Functional models of UMTS and integration into future networks' see page 167, paragraph 4 - page 168, paragraph 5 see page 168, paragraph 6 - page 172, paragraph 8 --- -/--	1-3

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 95/00988

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO,A,95 15635 (BRITISH TELECOMMUNICATIONS PLC.) 8 June 1995 see page 12, line 34 - page 13, line 20 see page 11, line 33 - page 12, line 13 see page 10, line 24 - page 11, line 19 see page 9, line 7 - line 10 see page 8, line 1 - line 20 see page 7, line 12 - line 19 see page 6, line 29 - line 37 see page 5, line 23 - page 6, line 8	1,7-9

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 95/00988

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